

Claims:

We claim:

- 5 1. A supercritical fluid cleaning process for cleaning substrates, comprising the steps:
  - (a) soaking at least one said substrate in a process fluid in a pressure vessel at a supercritical temperature and a higher of two supercritical pressures for a predetermined soak period;
  - (b) rapidly decompressing said pressure vessel to a lower of said two supercritical pressures; and
  - 0 (c) flushing said pressure vessel with said process fluid.
2. A supercritical fluid cleaning process according to claim 1, further comprising repeating said steps (a), (b), and (c).
- 5 3. A supercritical fluid cleaning process according to claim 2, said process fluid comprising carbon dioxide and selected additives in solution.
4. A supercritical fluid cleaning process according to claim 1, said process being conducted as repetitive cycles with a processed substrate being unloaded and a new said substrate being loaded into said pressure vessel for each consecutive cycle.
- 20 5. A supercritical fluid cleaning process according to claim 1, said process comprising the initial step of purging and pressurizing said pressure vessel so as to displace all other gases with said process fluid.
- 25 6. A supercritical fluid cleaning process according to claim 5, said process comprising the concluding steps of:
  - rinsing said substrate with said process fluid; and

drying said substrate by maintaining said pressure vessel at said supercritical temperature while decreasing vessel pressure to ambient.

7. A supercritical fluid cleaning process for cleaning substrates comprising the steps:

5 (a) loading, closing and sealing at least one substrate in a pressure vessel, said vessel being connected to a source of carbon dioxide,

(b) purging and pressurizing said vessel with said carbon dioxide to a higher of two supercritical pressures while heating said vessel to a supercritical temperature so as to displace all other gases with said carbon dioxide in a supercritical phase condition without entering a liquid phase condition,

0 (c) soaking said substrate at said higher supercritical pressure for a predetermined soak period,

(d) agitating said substrate by rapidly decompressing said vessel to a lower of said two supercritical pressures and flushing said vessel with said carbon dioxide in a supercritical phase condition for a predetermined period of time, then elevating said vessel to said higher supercritical pressure,

5 (e) rinsing said substrate with said carbon dioxide at said higher supercritical pressure,

(f) drying said substrate with said carbon dioxide by maintaining said vessel at said supercritical temperature while decreasing vessel pressure to ambient without entering a liquid phase condition,

20 (g) opening said vessel and unloading said substrate.

8. A supercritical fluid cleaning process according to claim 7, further comprising at least one repetition of steps (c) and (d) sequentially for at least two iterations thereof during said process.

25 9. A supercritical fluid cleaning process according to claim 8, said process being conducted as repetitive cycles with a processed said substrate being unloaded and an unprocessed said substrate being loaded for each consecutive cycle.

10. A supercritical fluid cleaning process according to claim 9, said vessel configured as an inverted vessel with an underside vertically operated lid upon which said substrate is mounted for said processing.

11. A supercritical fluid cleaning process according to claim 10, said vessel being also connected to a source of a process fluid mixture of said carbon dioxide and selected additives, said step of purging and pressurizing be followed immediately thereafter by the step of:

replacing said carbon dioxide in said pressure vessel with said process fluid mixture in said supercritical phase condition.

12. A supercritical fluid cleaning process for cleaning precision surfaces comprising the steps:

(a) selecting process materials comprising carbon dioxide as a process gas which is convertible at a critical point of temperature and pressure to a supercritical fluid for said cleaning process, and additives soluble in said process gas so as to form a supercritical fluid mixture;

(b) selecting supercritical fluid phase operating parameters for said mixture including a supercritical temperature, a lower supercritical pressure, and a higher supercritical pressure;

(c) loading, closing and sealing at least one substrate with a said precision surface in a pressure vessel, said vessel being connected to a source of said process gas and a source of said supercritical fluid and a source of said supercritical fluid mixture, and having at least one port for exhausting byproducts of said process;

(d) purging and pressurizing said vessel with said process gas and supercritical fluid to said higher supercritical pressure while heating said interior to said supercritical temperature so as to displace all other gases with supercritical fluid without entering a liquid phase condition,

(e) filling said vessel with said supercritical fluid mixture so as to replace said supercritical fluid,

(f) soaking said substrate at said higher supercritical pressure for a predetermined soak period,

(g) agitating said substrate by rapidly decompressing said vessel to said lower supercritical pressure and flushing said vessel with said supercritical fluid for a predetermined period of time, then elevating said vessel to said higher supercritical pressure,

(h) rinsing said substrate with said supercritical fluid at said higher supercritical pressure,

(i) drying said substrate by maintaining said vessel at supercritical temperature when decreasing vessel pressure to ambient without entering a liquid phase condition,

(j) opening said vessel and unloading said substrate.

5 13. A supercritical fluid cleaning process according to claim 12, further comprising at least one repetition of steps (f) and (g) sequentially for at least two iterations thereof during said process.

14. A supercritical fluid cleaning process according to claim 13, said process being conducted as repetitive cycles with a processed said substrate being unloaded and an unprocessed said

0 substrate being loaded for each consecutive cycle.